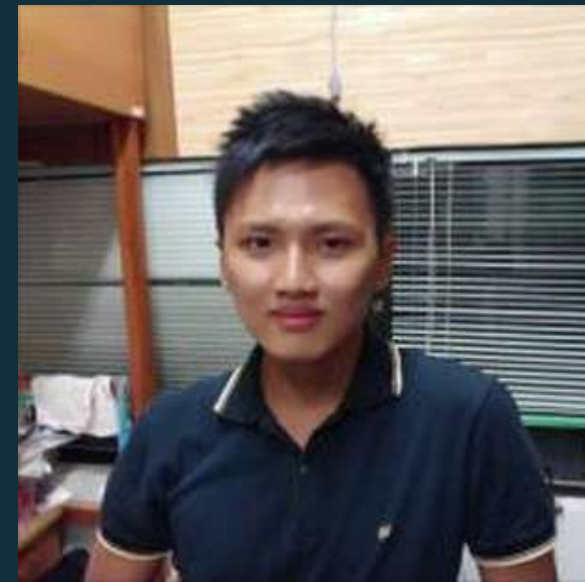
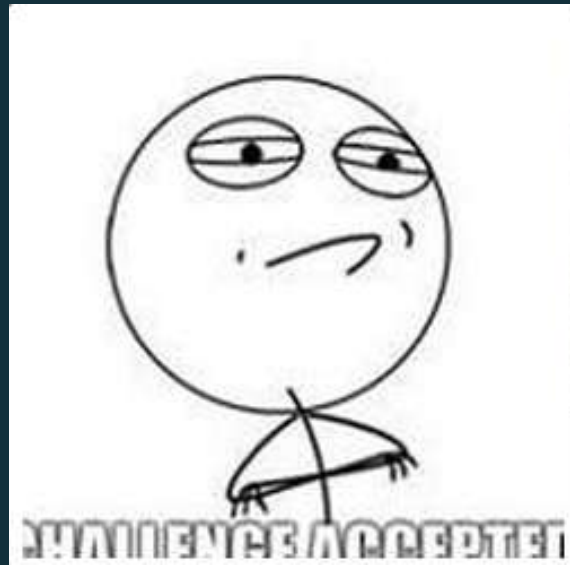


A microscopic image showing several red blood cells containing malaria parasites. The parasites are visible as dark, ring-like structures within the cells, some showing characteristic 'cherry-spoon' or 'doughnut' shapes. The background is a light, slightly textured blue.

**Biochip
malaria detection**

生醫三帥



何盈儒

王鉞

吳振豪

S

10/1

10/3

11/2

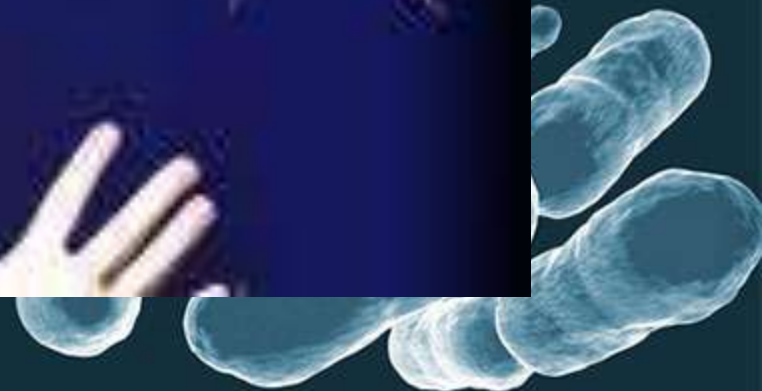
12/1

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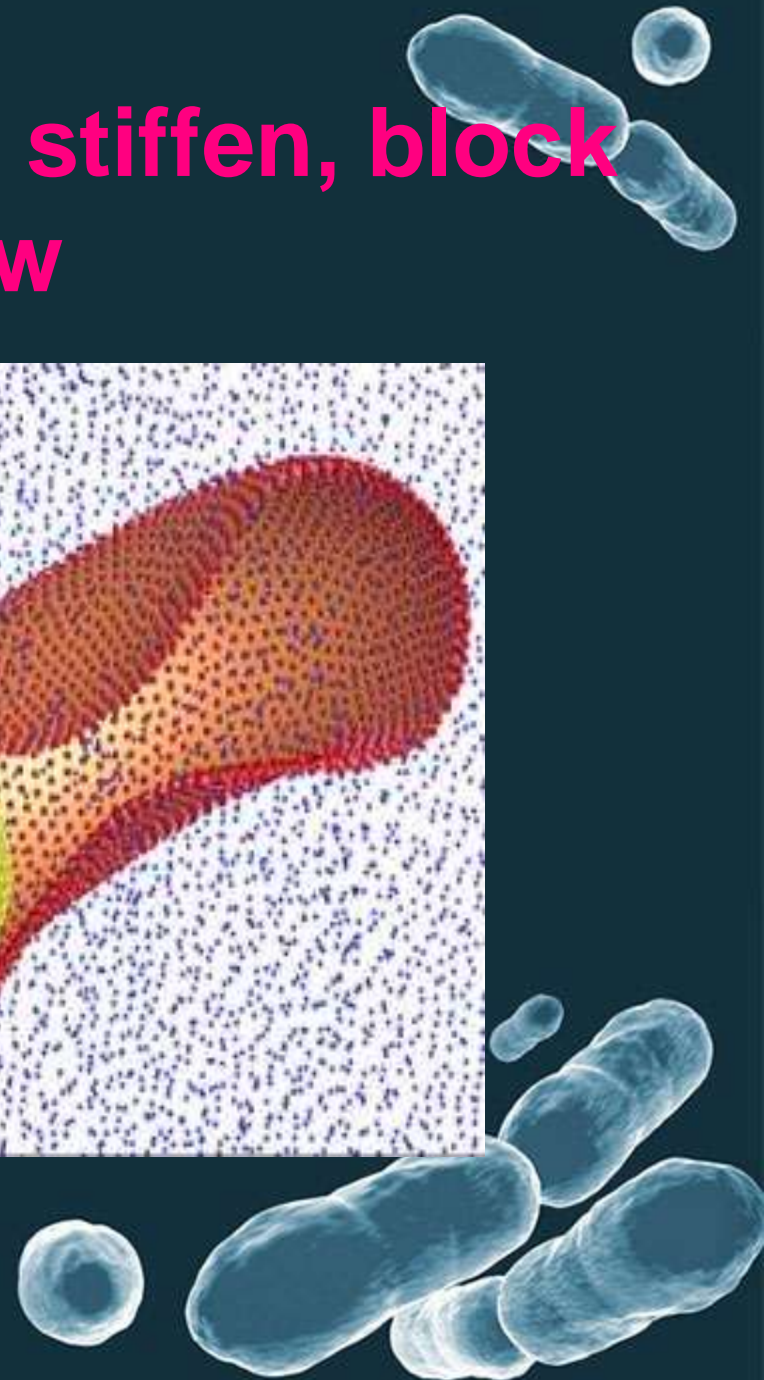
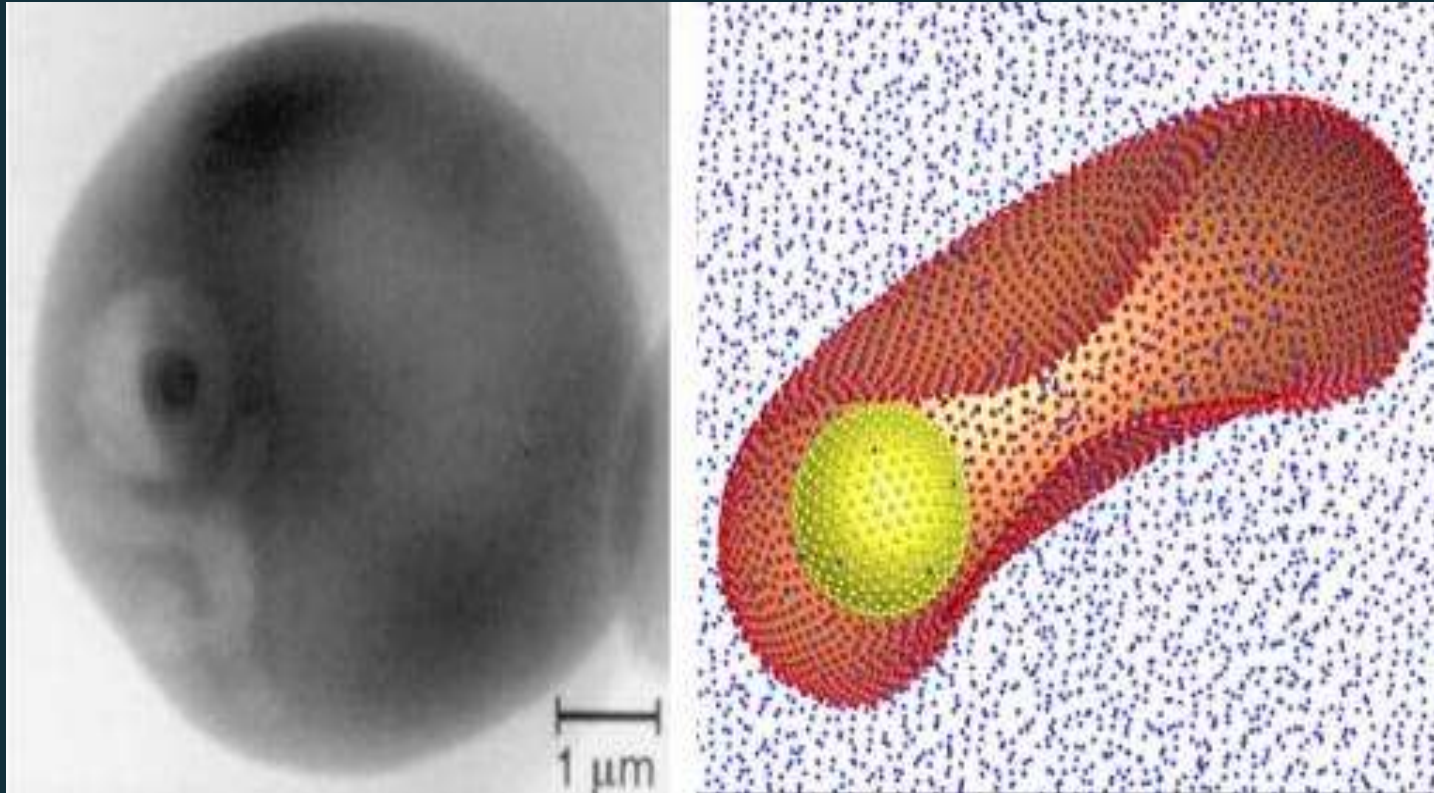
What do we
care most?

Bill Gates



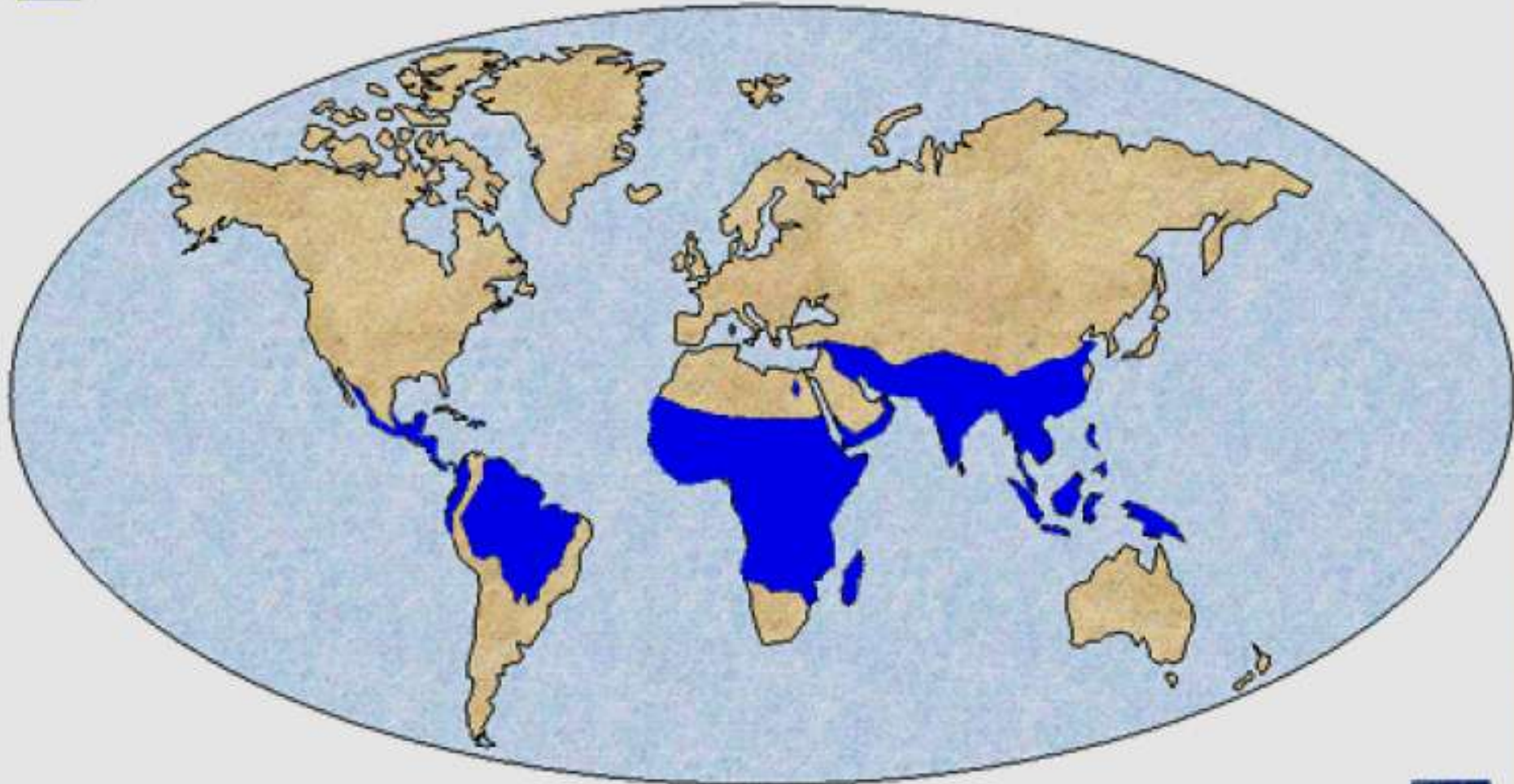
Malaria

Malaria-infected cells stiffen, block blood flow



2.1 billion people live in MALARIOUS areas

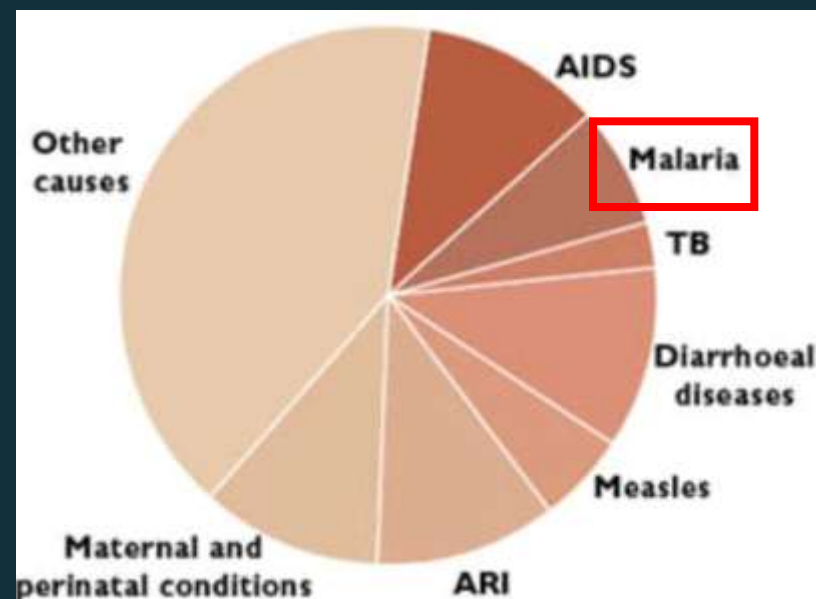
 Distribution of Malaria



That's right:
300 million new cases per year
making it the most prevalent serious
infectious disease!



HIV/AIDS, Tuberculosis and Malaria: The basic facts, 2002 (World Health Organization)			
Disease	Deaths per year	New cases per year	Percentage in developing countries
HIV/AIDS	3 million	5.3 million	92%
Tuberculosis	1.9 million	8.8 million	84%
Malaria	1 million	300 million	99.9%



Leading causes of death in Sub-Saharan Africa, South Asia, and Southeast Asia for persons age 0-44 (World Health Organization)



Factors we concern

- Cost (productivity)
- Sensitivity (parasites/mL)
- Usability
- Accuracy
- Species of malaria
- Detection speed

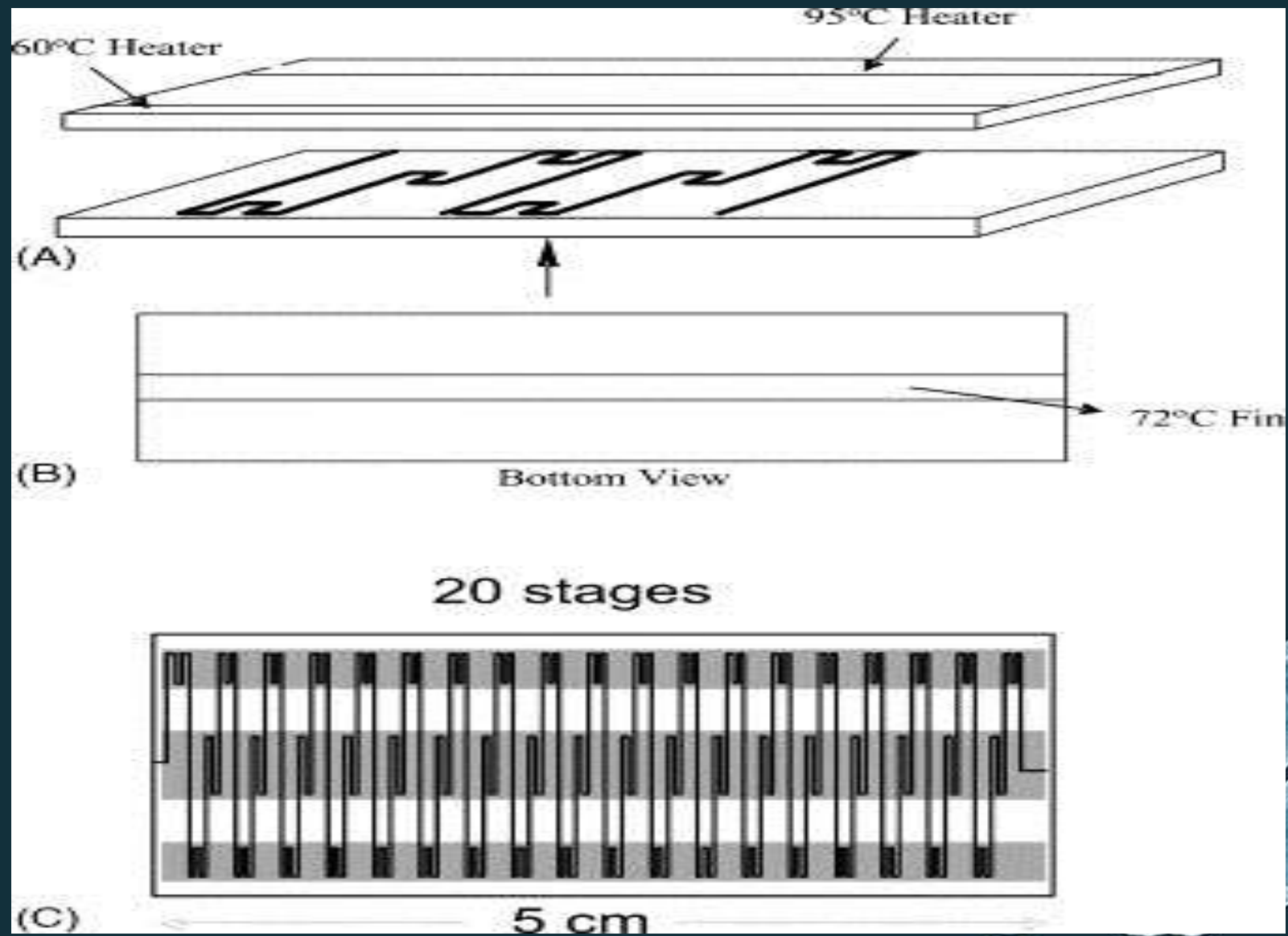
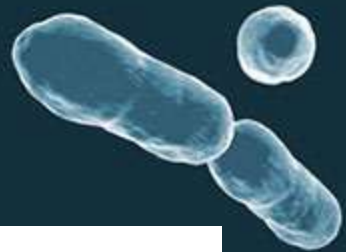


From microscopy to PCR

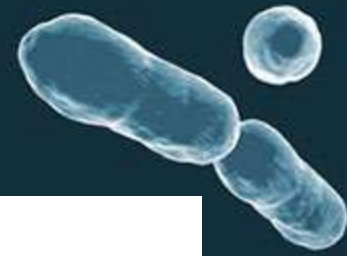


1. **polymerase chain reaction**
2. amplify DNA pieces
3. Denaturation, Annealing, Extension

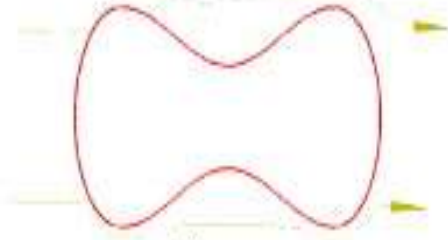




Different Physical



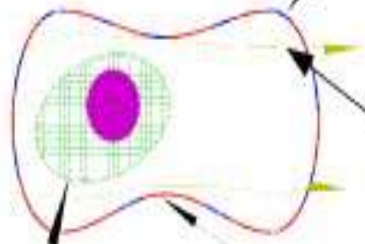
Normal erythrocyte



At low frequencies, electrical field lines do not enter normal erythrocytes

Host membrane becomes "leaky" to ions

Parasitized erythrocyte

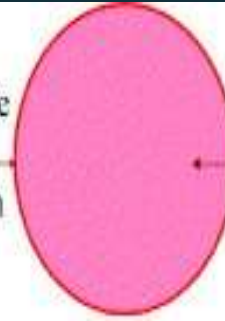


At low frequencies, electrical field lines enter parasitized erythrocytes

Parasite

Shape and volume of parasitized cells becomes modified

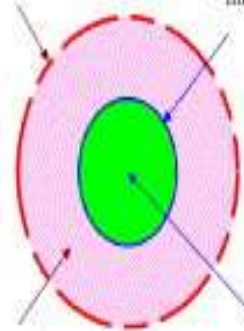
Normal membrane
 $\epsilon_{rmem} = 4.44 \pm 0.45$
 $\sigma_{mem} < 10^{-6} \text{ S/m}$



Normal interior
 $\epsilon_{rin} = 59 \pm 6$
 $\sigma_{in} = 0.31 \pm 0.03 \text{ S/m}$

Host membrane
 $\epsilon_{rmem} = 9.03 \pm 0.82$
 $\sigma = 7 \pm 2 \times 10^{-5} \text{ S/m}$

Parasite membrane
 $\epsilon_{rmem} = 8 \pm 4$
 $\sigma_{mem} < 10^{-6} \text{ S/m}$



Host interior
 $\epsilon_{rin} = 58 \pm 10$
 $\sigma_{in} = (0.95 \pm 0.05) \cdot \sigma_{ext}$

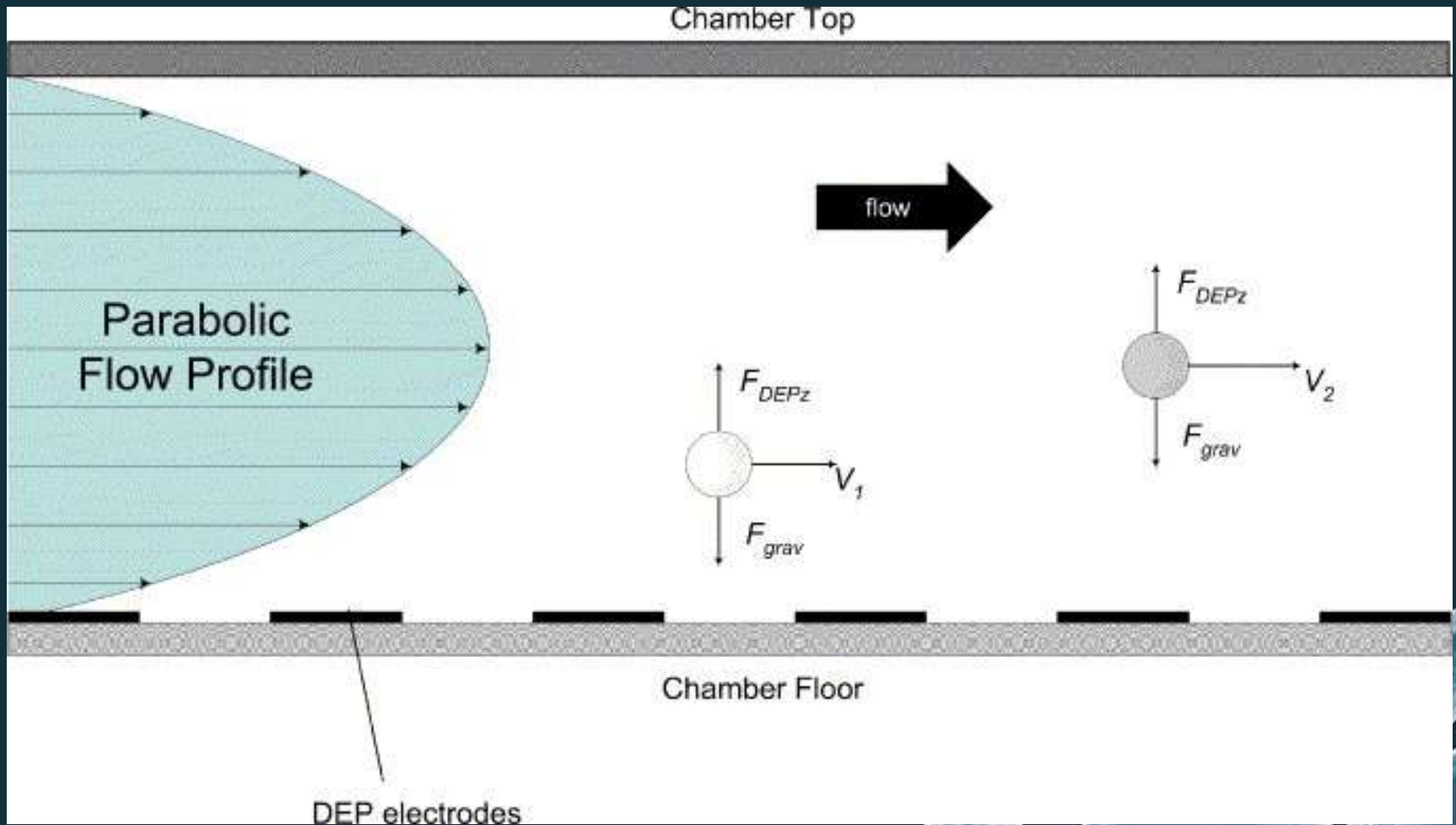
Parasite interior
 $\epsilon_{rin} = 70 \pm 5$
 $\sigma_{in} = 1.0 \pm 0.4 \text{ S/m}$

Biophysical Characteristics

Dielectric Characteristics



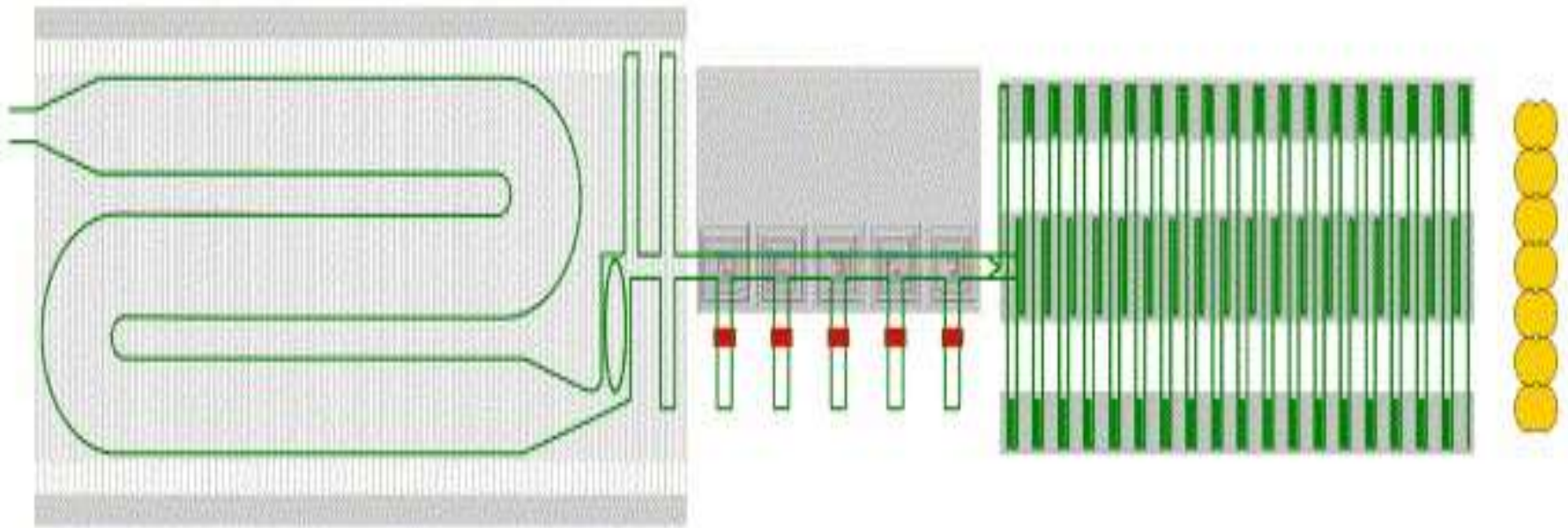
DEP electrodes



System



Integrated Fluidic Chip



DEP-FFF cell separator stage

Cell isolator and lysis stage

flow-through PCR and detector stage



New solution

- Golden standard(microscopy)

- Sensitivity, specificity, accuracy, precision, reliability, general parameters

- Accuracy

- Specificity -> All

- Detection limit -> High resolution
technique

Cost

Usability

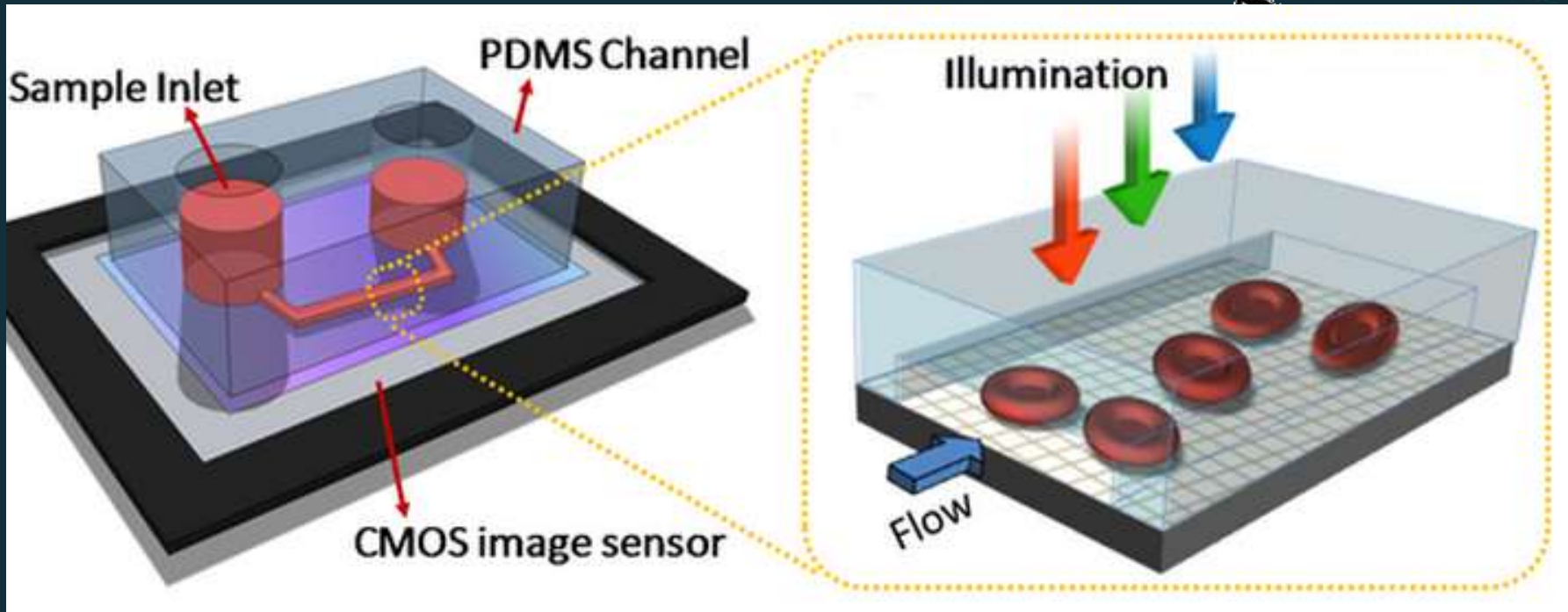


New solution

- How about CMOS image sensor?
 - Use CMOS sensor to implement Golden standard method
 - Optofluidic microscope



New solution



New solution

- Cost (productivity)
- Usability
- Sensitivity (parasites/ μL)
- Accuracy
- Species of malaria
- Detection speed



瘦肉精



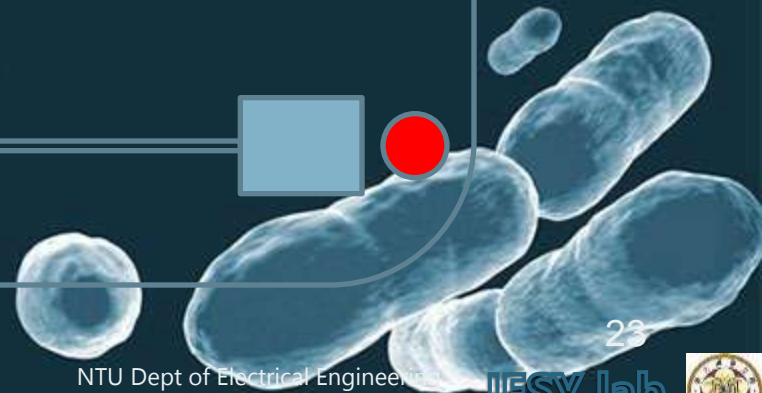
Microfluidics

Mechanism

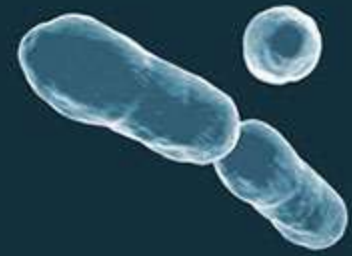
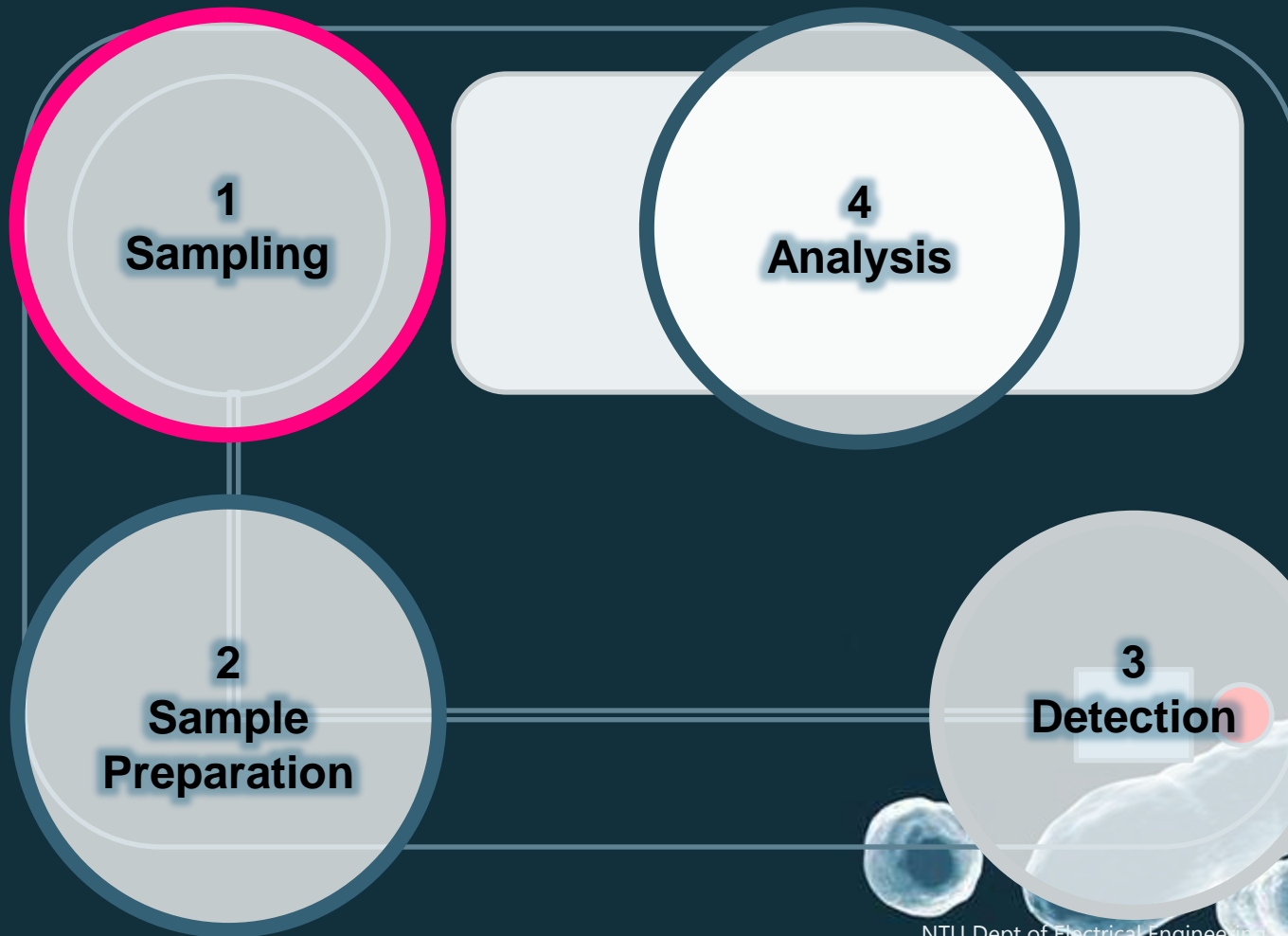


Mechanism

You have malaria



Former solution



Reference

- **PCR as a Confirmatory Technique for Laboratory Diagnosis of Malaria**
- **Microfluidic approaches to malaria detection**
- **High-speed microfluidic differential manometer for cellular-scale hydrodynamics**
- **Microfluidics for cell-based assays**



Reference

- Removal of malaria-infected red blood cells using magnetic cell separators: A computational study
- Color capable sub-pixel resolving optofluidic microscope and its application to blood cell imaging for malaria diagnosis
- Sample pretreatment and nucleic acid-based detection for fast diagnosis utilizing microfluidic systems
- Malaria: integrated approaches for prevention and treatment



Reference

- **Optofluidics for biophotonic applications**
- **Optical imaging techniques for point-of-care diagnostics**
- **Removal of malaria-infected red blood cells using magnetic cell separators: A computational study**
- **Rapid Diagnosis of Malaria**
- **Comparison of five methods of malaria detection in the outpatient setting**
- **Toward fast malaria detection by secondary speckle sensing microscopy**

